6N138

High Sensitivity, High Speed OPIC Photocoupler

■ Features

1. High current transfer ratio
   (CTR : MIN. 300% at $I_F = 1.6$mA)
2. High speed response
   ($t_{PHL}1$: TYP. 2 μs at $R_L = 2.2$kΩ)
3. Instantaneous common mode rejection
   voltage(CM_H : TYP. 500V/μs)
4. TTL compatible output
5. Overseas standard model
6. Recognized by UL, file No. E64380.

■ Applications

1. Interfaces for computer peripherals
2. Electronic calculators, measuring instruments,
   control equipment
3. Telephone sets
4. Signal transmission between circuits of
   different potentials and impedances

■ Outline Dimensions   (Unit : mm)

① NC   ⑤ GND
② Anode   ⑥ Vo
③ Cathode   ⑦ Va
④ NC   ⑧ Vcc

* "OPIC" (Optical IC)is a trademark of the SHARP Corporation.
An OPIC consists of a light-detecting element and signal-processing circuit integrated onto a single chip.

■ Absolute Maximum Ratings   (Ta = 25℃)

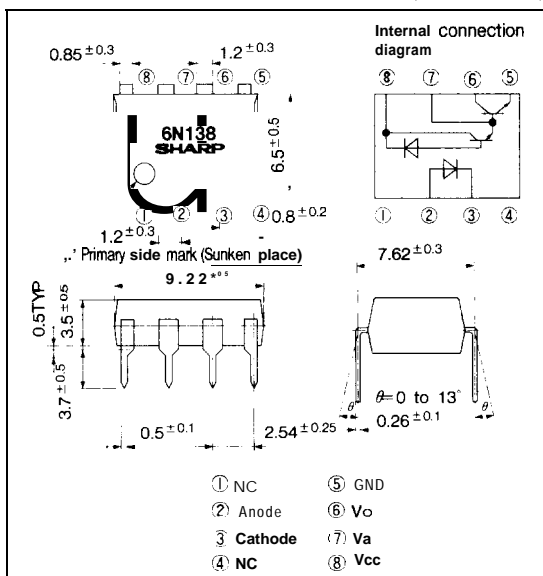|	Parameter	Symbol	Rating	Unit
Input	Forward current	I_F	20	mA
	*1 Peak forward current	I_F	40	mA
	*2 Peak transient forward current	I_{FM}	1	A
	Reverse voltage	V_R	5	V
	Power dissipation	P	35	mW
output	Supply voltage	V_{CC}	−0.5 to +7	v
	Output voltage	$V()$	−0.5 to +7	v
	Emitter-base reverse withstand voltage (pin 5 to 7)	V_{EBO}	0.5	V
	*3 Average output current	I_0	60	mA
	Power dissipation	$P()$	100	mW
	'Isolation voltage	V_{iso}	2500	V_{rms}
	Operating temperature	T_{opr}	o to +70	℃
	Storage temperature	T_{stg}	−55 to +125	℃
	*'Soldering temperature	T_{sol}	260	℃

*1 50% duty cycle, Pulse width = 1ms
*2 pulse width ≤ 1 μs, 300pps
*3 Decreases at the rate of 0.7mA/℃ if the external temperature is 25℃ or more.
*4 40 to 60% RH, AC for 1 minute
*5 For 10 seconds

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Photocouplers

■ Electro-optical Characteristics   (Ta = O to 70℃ unless otherwise specified)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
*) Current transfer ratio	CTR	$I_F = 1.6mA, V_O = 0.4V, V_{CL} - 45V$	300	1600	–	%
Logic (0) output voltage	V_{OL}	$I_O = 4.8mA, tct = 45Y, I_F 1.6mA$	–	0.1	0.4	V
Logic (1) output current	$IO][$	$I_F = 0, V_{CC} - V_O = 7V$	--	0.1	250	μA
Logic (0) supply current	I_{CCL}	$I_F 1.6mA, V_{CC} = 5V, V_O =$ open	–	0.5	--	mA
Logic (1) supply current	I_{CCH}	$I_F = 0, V_{CC} = 5V, V_O = $ open	–	10		nA
Input forward voltage	V_F	$I_F = 1.6mA, Ta = 25℃$		1.5	1.7	v
Input forward voltage temperature coefficient	*2	$I_F = 1.6mA$		−1.9	–	mV/℃
Input reverse voltage	BV_R	$I_R = 10\mu A, Ta = 25℃$	5.0	–		v
Input capacitance	C_{IN}	$V_F = 0, f = 1MHz$		60		pF
*3 Leak current (input -output)	I_{LO}	$Ta = 25℃, 45\%RH, t = 5 s$ $V_{IO} = 3kV DC$			1.0	μA
*3 Isolation resistance (input -outPut)	R_{IO}	$V_{IO} = 500V DC$		10^{12}	–	Ω
*3 Capacitance (input-output)	C_{IO}	$f = 1MHz$	–	0.6		pF

*1 Current transfer ratio is a ratio of input current and output current expressed in %.   Note) Typical value at Ta 25℃, V_{CC} 5V

*2 $\Delta V_F / \Delta Ta$

*3 Measured as 2-pin element (Short 1,2,3,4 and 5,6,7, 8.)
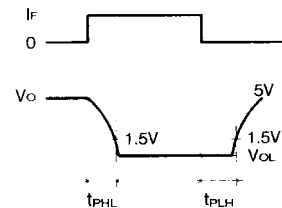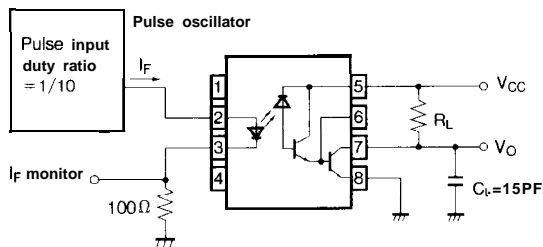
■ Switching Characteristics   (Ta = 25℃, V_{CC} = 5V)

Parameter	Symbol	Conditions	MIN.	TYP.	MAX.	Unit
*4 Propagation delay time output (1) → (0)	t_{PHL}	$I_F = 1.6mA$ $R_L = 2.2k\Omega$		2	10	μS
*4 Propagation delay time output (0) → (1)	t_{PLH}	$I_F = 1.6mA$ $R_L = 2.2k\Omega$		7	35	μS
*5 *6 Instantaneous common mode rejection voltage "output (1)"	CMn	$I_F = 0, V_{CM} = 10 V_{PP}$ $R_L = 2.2k\Omega$		500		$V/\mu s$
*5 *6 Instantaneous common mode rejection voltage "output (O) "	CM_L	$I_F = 1.6mA, V_{CM} = 10VP.P$ $R_L = 2.2k\Omega$		- 500	--	$V/\mu s$

*5 Instantaneous common mode rejection voltage "output (1)" represents a common mode voltage variation that can hold the output above (1) level $(V_O > 2.0V)$.

Instantaneous common mode rejection voltage "output (0)" represents a common mode voltage variation that can hold the output above (0) level $(V_O < 0.8V)$.

*4 Test circuit for Propagation Delay Time

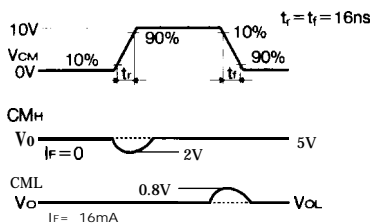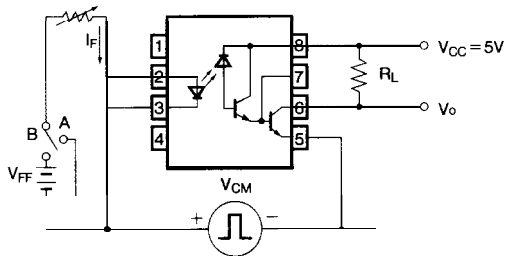## *6 Test Circuit for Instantaneous Common Mode Rejection Voltage

$t_r = t_f = 16ns$

$V_{CC} = 5V$

R_L

V_o

V_{CM}

V_{FF}

10V

V_{CM} 90% 10%

0V 10% 90%

CMH

V_0 2V 5V

$I_F = 0$

CML

V_O 0.8V V_{OL}

$I_F = 16mA$

Fig. 1 Forward Current vs. Ambient Temperature

Forward current I_F (mA)

Ambient temperature T_a (℃)
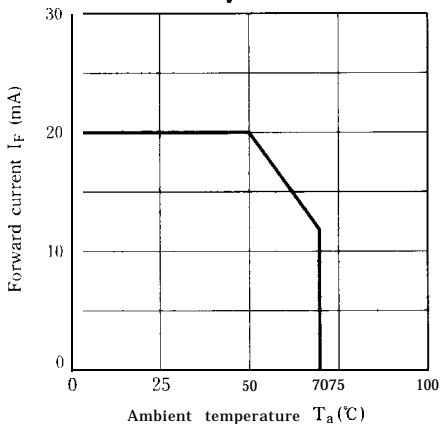
Fig. 2 Power Dissipation vs. Ambient Temperature

P_O

P

Power dissipation P, P_o (mW)

Ambient temperature T_a (℃)
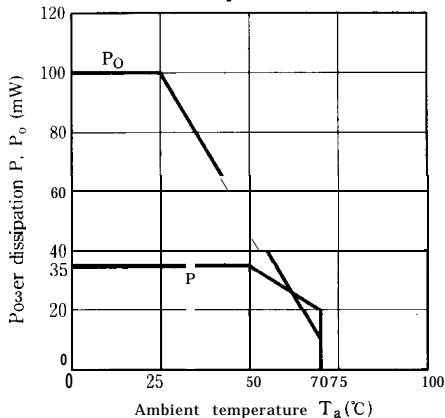
Fig. 3 Forward Current vs. Forward Voltage

Forward current I_F (mA)

$T_a = 0℃$

25℃

50℃

70℃

Forward voltage V_F (V)
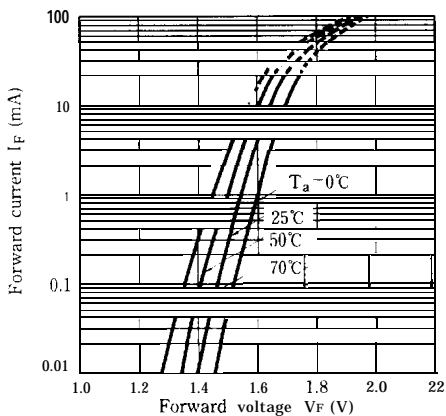
Fig. 4 Output Current vs. Output Voltage

$V_{CC} = 5V$

$T_a = 25℃$

$I_F = 5mA$

$P_O (MAX)$

4.5mA

4.0mA

3.5mA

3.0mA

2.5mA

2.0mA

1.5mA

1.0mA

0.5mA

Output current I_O (mA)

Output voltage V_O (V)

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rs

Ph
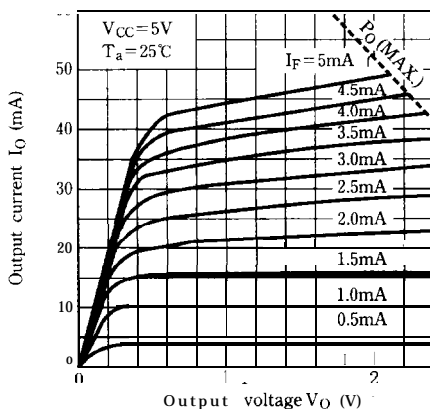
Fig. 5 Current Transfer Ratio vs. Forward Current

Current transfer ratio CTR (%) vs. Forward current I_F (mA)

$V_{CC} = 4.5V$
$V_O = 0.4V$
$T_a = 70°C$
$25°C$
$0°C$
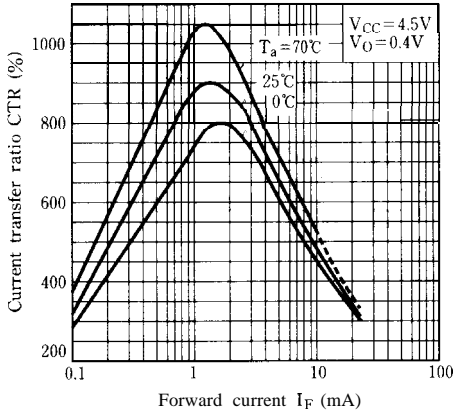
Fig. 6 Output Current vs. Forward Current
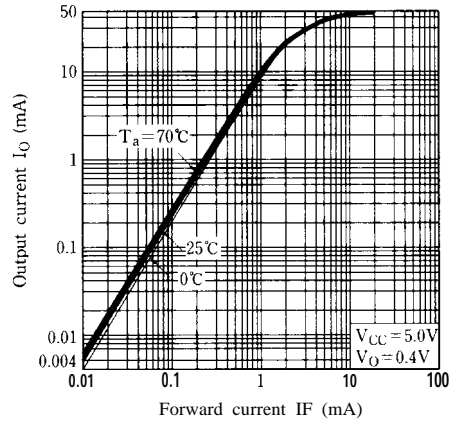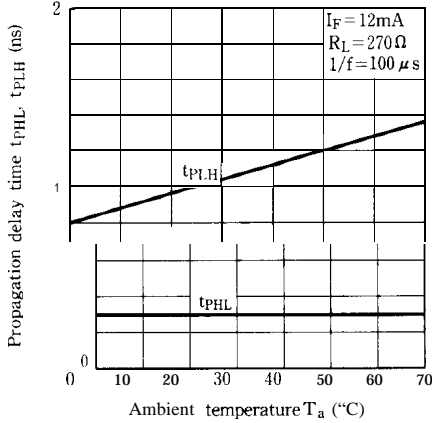
Output current I_O (mA) vs. Forward current IF (mA)

$T_a = 70°C$
$25°C$
$0°C$
$V_{CC} = 5.0V$
$V_O = 0.4V$

Fig. 7-a Propagation Delay Time vs. Ambient Temperature

Propagation delay time t_{PHL}, t_{PLH} (ns) vs. Ambient temperature T_a ("C)

$I_F = 12mA$
$R_L = 270Ω$
$1/f = 100μs$

t_{PLH}
t_{PHL}

Fig. 7-b Propagation Delay Time vs. Ambient Temperature

Propagation delay time t_{PHL}, t_{PLH} (ns) vs. Ambient temperature T_a (°C)
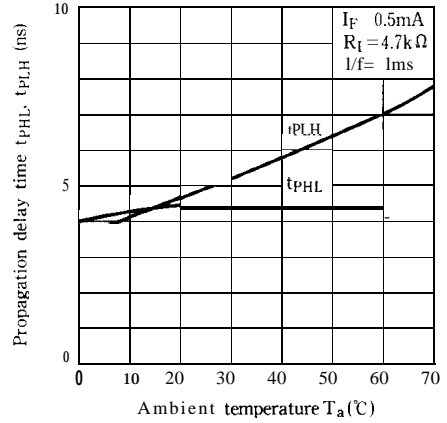
I_F $0.5mA$
$R_I = 4.7kΩ$
$1/f=$ $1ms$

t_{PLH}
t_{PHL}

Fig. 8 Rise Time, Fall Time vs. Load Resistance

Rise time, fall time t_r, t_f (μs) vs. Load resistance R_L (kΩ)
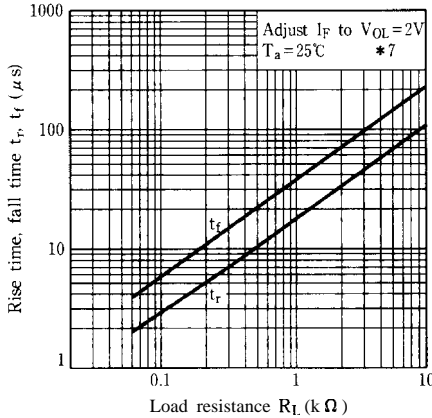
Adjust I_F to $V_{OL} = 2V$
$T_a = 25°C$ *7

t_f
t_r

Fig. 9 Logic (1) Supply Current vs. Ambient Temperature

Logic (1) supply current I_{CCH} (A) vs. Ambient temperature T_a (°C)

$I_F = 0mA$
$V_{CC} = 15V$
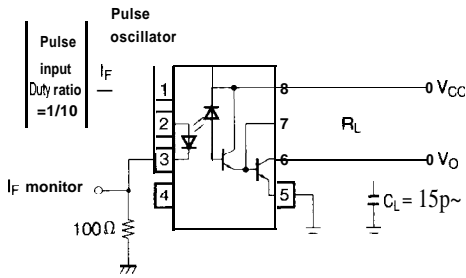$V_O = OPEN$
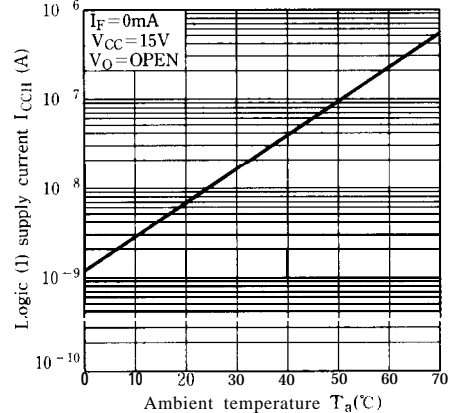
*7 Test Circuit for Rise Time, Fall Time vs. Load Resistance
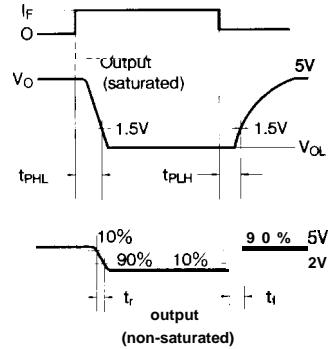
■ Precautions for Use

(1) It is recommended that a by-pass capacitor of more than 0.01 μF be added between Vcc and GND near the device in order to stabilize power supply line.

(2) Transistor of detector side in bipolar configuration is apt to be affected by static electricity for its minute design. When handling them, general counterplan against static electricity should be taken to avoid breakdown of devices or degradation of characteristics.

(3) As for other general cautions, refer to the chapter "Precautions for Use" (Page 78 to 93)

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